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ON THE RELATIONSHIP BETWEEN DEVELOPMENT AND THE SEXUAL CONDITION IN PLANTS.

BY JOHN STOCKTON-HOUGH, M. D.

INDIAN CORN (*Zea Mays*) is sexually monœcious, that is, the male and female flowers are normally on different parts of the same plant. Occasionally, however, the female flowers appear among the male flowers, on the same raceme, and more rarely, the male flowers appear on the spike (ear) among the female flowers, and still more rarely, they are hermaphroditic.

Other observers reverse the order of rarity of these anomalies and say that "male flowers sometimes appear amongst the female flowers, and Mr. J. Scott has lately observed the rarer case of female flowers on a true male panicle, and likewise hermaphrodite flowers." *

The writer collected and examined nearly a hundred specimens of these anomalies (female flowers among the males), during the last autumn (1872) with a view of determining the relationship between the *proportion* or excess of either *sexual element* and the condition of *development* of the *plants* bearing such anomalous flowers.

The stalks bearing female flowers among the males were almost without exception "*suckers*," that is, branches coming off from the main stalks at the nodes among the adventitious roots just below the surface of the ground. The junction of one of these "suckers" with the stalk on which it is a parasite, so to speak, is greatly constricted, and the point of attachment is scarcely more than an eighth of an inch across. There are few, if any, serviceable adventitious roots to these suckers, so the stalk derives its nourishment wholly from the trunk to which it is joined, and as a consequence such stalks are short, slim and pale in color, having abridged internodes, or in other words, *they are undeveloped.* A wet season, injury to the main stalk, shady locations and the borders of fields, seem to favor their production.

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* Darwin, Variations in Animals and Plants under Domestication, out of Trans. of Botan. Soc. of Edinburgh, vol. viii, p. 60.

From what has been brought forward, it would appear as if these sexual anomalies were the result of *deficient nutrition*, from which resulted *defective development* and *restrained evolution* of the sexual organs.

There were many stalks to be found, bearing male flowers ("tassels") alone in the normal position (terminal), apparently perfect males in size and development, but no stalks are to be found bearing a complete spike (ear) of perfect female flowers alone, even when terminal. Such spikes (ears) are always defective, often being but partially filled with grains, even when no male flowers are present.

The spike (ear) is only an undeveloped branch, sometimes having two or three internodes it is true, but it is generally sessile.

When the ear is in the normal position, no matter how much the female flowers may prevail or how defective they are, the male flower always normally appears in the terminal part of the main stem or stalk. Not so with the wholly male plant, which has a tassel in the normal position (terminal) without a sign of a place for a female flower.

When the ear (female spike) abnormally bears male flowers, they are usually terminal on the cob, though sometimes they may be on any other part of the ear, even a single male flower among the closely crowded grains (females). Mr. Scott, as already mentioned, speaks of having found even hermaphrodite flowers, which would naturally appear to be much more rare among diœcious plants than among the monœcious, for the latter condition would appear to stand between the diœcious and the hermaphroditic.

Great numbers of corn plants bear male flowers only, while none are female alone, and wherever they approach the latter condition, the spike (ear) of female flowers is terminal. These exclusively male plants are usually as large as if not indeed larger than the normal kind (monœcious) and are certainly more rank and vigorous in their growth than those plants which bear principally female flowers on the terminal part of the plant, which latter, as I have already said, are much shorter, more slender, and pale in color.

The following table will indicate these differences. Fifty specimens of plants of Indian corn, having an abnormal sexual arrangement of the flowers, had the following proportions:—

	Exclusively male stalks (diœcious).	Normal stalks, male and female (monœcious).	Stalks having a few female flowers in the male panicle (approaching hermaphroditism).	Stalks having nearly all the flowers female and terminal (nearly diœcious).
Average height.	124 in.	118 inches.	88 inches.	46 inches.
Terminal internodes.	7-11 in.	6-10 "	4-6 "	½-2½ "

From this showing it appears that in proportion to the participation or predominance of the female element, just in that proportion does the plant decline in size and development, and we are forced to conclude, as we have shown in several other articles,* that *females are undeveloped males*, and this is true in plants as well as among animals.

In some cases where the female flowers were on the male panicle, instead of forming a single large ear, as was usually the case, each branch of the panicle bore grains separately, which must have resembled what Bonafous mentions as a variety called Cymosa, which has its ears so crowded together that it is often called *maïs à bouquet*. Some of the specimens examined by me had the appearance as if the cob had been separated into several segments, triangular in shape, bearing corn only on one side (the outer) of the triangle.

Returning to those stalks bearing male flowers alone and which, I have said, are tallest, most rank, and best developed,—I would suggest that the absence of female flowers was due to retarded fecundation of the ovules from which such stalks were produced. This point might be practically tested by planting a single stalk in a field far removed from any other corn. The tassel should be cut off as often as required to prevent the male flowers from forming, then the pollen from another plant should be applied to the female flower at the latest moment when fecundation is possible. By this method we should expect to get the largest possible proportion of exclusively male-generating grains. To get the largest possible proportion of female-producing grains, the female flower should be fecundated at the earliest possible moment—earlier than nature does it. The grains produced under these circumstances would, when planted, give the largest and the smallest proportion of exclusively male or female plants.

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*Longevity and other biostatic peculiarities of the Jewish race. N. Y. Medical Record, May 15, 1873. pp. 241, 2, 3, 4. The Relative Viability of the Sexes, etc. N. Y. Medical Record, June 16 and July 15, 1873. pp. 9. The Laws of Transmission of Resemblance from Parents to their Children. N. Y. Medical Record, Aug. 15, Sept. 15, Oct. 15, and Nov. 15, 1873. pp. 16. Statistics Relating to Births, Marriages and Deaths, and Movement of Population in Philadelphia, for the eleven years ending 1871. Penn. Monthly, Sept., 1873. pp. 24. Papers of the Social Sci. Assoc. of Philadelphia, 1873. The Physical Aspects of Primogeniture. N. Y. Medical Record, Jan. 15, and Feb. 15, 1874. The Temperature of the Sexes, an Indication of Development. Phil. Times. Nov. 8th, 1873. pp. iii. Nativity of Parents, as Influencing the Fecundity and Proportion of Sexes in births in general, and in twin, illegitimate, and still-births in particular, Phil. Med. Times, 1873. A new Theory as to the Cause of Enlargement of the Prostate Gland, etc. The Proximate Cause of Evolution.

An Inaugural Dissertation [presented to the Trustees and Faculty of the University of Pennsylvania, March 13, 1868, for the Degree of Doctor of Medicine], entitled; Prepotency, Sexual Elective Affinity, Non-congeniality, or the *dynamic differentiation* of the Elements of Reproduction in the Human Species; the cause of Relative Sterility; By John Stockton-Hough, A. M., M. Chem., of New Jersey; The Cause of Rotation and a nearly equal number of Sexes in Births."

It would be well to determine whether the grains near the tip, in the middle, or near the base of the ear, gave the largest proportion of exclusively male-producing grains. The following will illustrate how the facts might be tabulated:—

Grains.	Number of stalks no ear.	Stalks one ear.	Stalks two ears.	Whole number of ears.	Whole number of stalks.	Average number of ears to each stalk.
From tip	X	P	V	P+2V	X+P+V	$\frac{P+2V}{X+P+V}$
From middle	Y	T	W	T+2W	Y+T+W	$\frac{T+2W}{Y+T+W}$
From base	Z	N	O	N+2O	Z+N+O	$\frac{N+2O}{Z+N+O}$

Metzger[*] has observed that the effect of climate on Indian corn, as cultivated in Germany, causes "the lower seeds in the ear to keep to their proper form, but the upper seeds become slightly changed."

"Among species of Carex, it is a common thing for the spike to consist of male flowers at the top, and female flowers at the base; though the converse is much more common."[†] Dickson, Mohl, Schleiden, Braun, Cranmer and others have observed cones of different species of pines, usually female, having male flowers in the lower part of the cone.

M. Charles Girou de Buzareignues[‡] has made many observations on the proportion of male and female plants produced from seeds taken from different parts of the hemp plant. He found that the seed taken from the lower, more mature, and more highly developed parts of the plant gave a much larger proportion of male-producing seed, than seed taken from the upper, more succulent, less mature, less highly developed parts, as the following figures will indicate. Of 125 hemp plants the proportion of males to females was—

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[*] Getreidearten, s. 206.

[†] Annales des Sciences Naturelles, t. xvi, p. 140, extracted from his De la Génération, 8vo, Paris, 1828.

[‡] Maxwell Masters; Vegetable Teratology, Ray Soc., London, 1869. 8vo, pp. 191 (Heterogamy); compare Hopkins' General View of the Anomalies in the Vegetable Kingdom, Glasgow, 1817, also, Moquin-Tandon; Éléments de Teratologie Végétal, 1841, p. 126, *et al.*

		Males	Females
1°	In the subjects taken from the weak plants,..........	692	1000
	In those which came from strong plants,..............	907	1000
2°	In the subjects taken from the seeds furnished by the *inferior half* of the stem of weak plants,............	1250	1000
	And in those which came from the *superior half*......	444	1000
3°	In the subjects taken from the seed furnished by the *inferior half* of the stem of strong plants,...........	1000	1000
	And in those which came from the *superior half*,......	827	1000

The same observer in subsequent experiments* declares that seeds from nearest the summit of the stem gave proportionally more females than those from the middle and base. The lower branches gave a larger proportion of males than the upper. I might repeat many similar experiments with the same result.

Concerning the size of the seeds, he says that the largest and smallest gave a predominating proportion of males, while those of the mean size gave more especially females.

The carefully made observations of Mr. Thomas Meehan of Germantown, Philadelphia Co., Penn., are singularly in harmony with those of Mr. Girou and others, though, I believe, made entirely independently of a knowledge of the latter.

Mr. Meehan† has observed that in several plants of the order Cupuliferæ, and he believes in all of them, "we find the female flowers only on the strongest young growths, and only at or near the apex of the first great wave of spring growth, as if it were the culmination of a great vegetative effort which produced them, instead of a decline as in the male."

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*Girou, Suite des Expériences sur la Génération des Plantes, Annales des Sciences Naturelles, t. xxiv, pp. 138–148.

†On the Sexes of the Plants, Proc. Amer. Assoc. Adv. Sci., 1869, pp. 256–60. See also, *ibid.*, 1870, pp. 276–280; *ibid.*, 1868, p. 317. Proc. Acad. Nat. Sci., 1868, 9, 70. Also Gardener's Monthly (edited by Mr. Meehan), 1870, p. 333, *et al. temp.* Also Dr. S. W. Butler's Review (editorial) of Mr. Meehan's observations and deductions, Medical and Surgical Reporter, Phila., Oct. 22, 1870, p. 330, *et al. loc. Op. cit.*; also, Mr. Meehan in Old and New, Feb., 1872, p. 173 *et seq.*

In the case of Norway spruces it is "only in the fourth or fifth year, when vitality in the spur is nearly exhausted, do male flowers abundantly appear."

Mr. David Moore, in his morphology of Nepenthes,* says that "vigor and healthiness increase the female line of vital force in vegetables, while weakness is more conducive to the male development." When growth has ceased, maturity and complete development are accomplished, and the business of reproduction exclusively occupies the plant.

From all this it appears then, that while the plant is mostly occupied in vigorous growth, while it is yet succulent, *immature*, or is, in other words, *undeveloped*, does it bear the largest proportion or principally female flowers. As growth is antagonistic to development, and it is only after perfect development is reached that the reproductive function is most active, we are forced to conclude that the production of male flowers or fruit is a higher effort of the plant than the production of females.

I have ventured to enunciate it as a law† deduced from a thorough study of the subject, that the greater the fecundity, in single births, the larger the proportion of male children, and *vice versa*. I have also said that the begetting of males is a higher role in the reproductive act of the mother than the begetting of females; while the begetting of females on the part of the father is a higher reproductive role than the begetting of males.‡ In this article it has been shown that the greater the "*vigor*" (rapidity of growth and excessive vital and vegetative action) the larger the proportion of females produced. Now, it is so well known and so universally recognized and pointed out by physiologists, that this same *vigor is directly antagonistic to reproduction*, that it is scarcely necessary for me to mention it. Hence females are begotten when the system is more occupied by the process of growth, reparation or disease, than when males are begotten.

Dr. Henry Hartshorne§ has maintained Mr. Meehan's view of the relation of vigor to sex. To the facts stated I fully agree, but the deductions which they have both arrived at, viz.: that the begetting of female offspring is a higher role on the part of the mother than the begetting of males, — that is, requires a more perfect developmental effort—and as a consequence, females are more highly developed than males, are diametrically opposed to my own conclusions, as may be seen in this and in the other papers referred to.

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*Trans. of the Royal Irish Acad., Vol. xxiv, p. 629, 1870.

†The Relative Viability of the Sexes, etc. N. Y. Medical Record, June 16, and July 15, 1873, p. 301; and Statistics of Philadelphia, Proc. Social Sci. Assoc., 1873, p. 18.

‡See farther, in the author's thesis, already alluded to, in foot-note; also his paper on Laws of Transmission, etc., etc.

§On the Relation between Vigor and Sex. Proc. Amer. Assoc. Adv. Sci., 1872, pp. 192–7.

The use of the word "vigor" is scarcely scientific; it has only a practical, conventional meaning, and should be studiously avoided by scientific biologists, as it is almost useless by way of comparison. Development is the proper physiological expression, and indicates the degree of evolution or maturity of the various organs of the animal or plant, and we can readily compare the different stages and degrees of development exhibited in each organ. Mr. Meehan studiously avoids the use of this last named word, and would, I am persuaded, alter his deductions if he should weigh its full meaning, and apply it in his comparisons. He cannot, however, be too highly praised for his excellent series of observations already alluded to.

With a view of showing the fallacy of the use of this word vigor, I may state that Dr. Gouverneur Emerson of Philadelphia, several years ago, discovered that "the extensive prevalence of every severe zymotic epidemic, or endemic disease; every occurrence, in fact, which exerts, either directly or indirectly, a decided, depressing effect upon a community, will be indicated in the record of births by a conspicuous reduction in the proportion of males."* He bases this opinion upon the careful study of the statistics of births in Philadelphia during the prevalence of cholera in the year 1833; also for Paris 1832. In the first named city, the percentage of excess of male births for the decade from 1830 to 1840 was 6·29, while "the diminution of male conceptions, during the cholera, was at the rate of 17 per cent." The number of conceptions during the months in which cholera prevailed was 1826 males and 1851 females, or 98·64 males to 100 females. In Paris, in 1832, the year cholera prevailed there, the excess of male conceptions was reduced from the usual average of 6 per cent. to 3½ per cent. From this we see that a "*lessened vigor*," so to speak, is accompanied by an increase in the proportion of female births; so a lessened or increased vigor may determine this increased tendency toward the production of females ; in fact, anything which operates upon the animal economy by distracting it from the business of reproduction, such as rapid and vigorous growth, developmental processes, mental anxiety, or incipient disease, will cause a lessened fecundity and an increase in the proportion of female offspring.

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*Causes operative in determining the Proportions of the Sexes at Birth. American Journal of the Medical Sciences, July, 1848, pp. 78-85.

Mrs. Mary Treat* of Vineland, N. J., has, by repeated experiments on butterflies, found that by overfeeding a certain number, a large proportion of female eggs was produced, and that by underfeeding, or partly starving them, the proportion of male eggs was increased.

The writer has shown in his paper on "The Nationality of Parents as Affecting the Fecundity and the Proportion of Sexes in Births"† that foreign mothers (who are unquestionably more "vigorous" than native mothers) have a much larger proportion of boys among their children.

Mr. H. H. Howorth, in his paper entitled "Strictures on Darwinism,"‡ says that he "cannot but conclude that sterility is induced by vigorous health and by a plentiful supply of the necessaries of life, while fertility is induced by want and debility, and that this law acts directly against Mr. Darwin's theory, in that it is constantly recruiting the weak and the decrepit at the expense of the hearty and vigorous, and is constantly working against the favorite scheme of Mr. Darwin, that in the struggle for existence the weak are always being eliminated by the strong."

It will be seen by the above that the views of Mr. Darwin and Mr. Howorth are both extreme; the former believing that the greatest fecundity and best products belong to the most vigorous, while the latter believes that the most feeble are most prolific, and have the most vigorous offspring.

The writer is of the opinion, from a careful study of the subject, that a medium condition between these two extremes is most favorable to fecundity and the production of healthy, vigorous offspring, namely, developmental maturity of the parents, and a moderate supply of food in connection with a life most in accordance with nature.

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* AMERICAN NATURALIST, March, 1873, Laws Controlling the Sexes in Butterflies.

† Philadelphia Medical Times, ... 1873.

‡ Journal of the Anthropological Institute. London, April, 1872, pp. 21-40. p. 37. Part 1, Fertility and Sterility.

We have seen, then, that excessive "vigor" increases the proportion of females; lessened "vigor" decreases the proportion of males (apparently increases the proportion of females); and that greater "vigor" increases the proportion of males: — from all of which we conclude that there is *no constant "relationship between 'vigor' and sex.*"

In my paper on the "Relative Viability of the Sexes, etc.," in which I have shown that females have a higher viability (greater longevity) than males, I ventured to ascribe this greater viability to the fact of female fetuses sapping the vitality of the mother more than males. However this be, there can be no doubt of the facts stated, for Prof. Martegoute* in his observations on the breeding of the Dishley Mauchamp merino sheep, says,—"Our monthly weighings show that the ewes that have produced female lambs are on an average of weight superior to those that produced the males; and they evidently lose more in weight than these last, during the suckling period; while the ewes that produce males, weigh less, and do not lose in nursing so much as the others."† "That is, mothers are in better condition when they *conceive* females, and are in better condition when they wean males than females." Dr. Congar‡ has observed the same thing concerning women. Dr. Spruce,§ a South American traveller, noticed that a certain palm (Geonoma) bore fruit (female flowers) one year, and male flowers the next, alternating from male to female from year to year. This same fact is seen in some animals, that bear females for several generations, then males; in fact the process of "alternation of generations" is dependent upon this principle, of which I shall have more to say in another paper.‖

I have stated that some stalks bore only male flowers, and suggested that this fact was the result of retarded fecundation of the ovule from which the stalk was produced, and I may now point out how nature allows these peculiarities to be produced.

It has been observed, says Lindley,¶ that the quantity and kind of light to which the plant is subjected determine the sex of the future products of the seeds produced under these circumstances. General Pleasonton* of this city has lately determined that both animals and plants thrive better under a violet colored light, which is in harmony with the experiments of Dr. Daubeny.† Mr. Thomas Andrew Knight‡ observed that the relative quantity of light and heat determined the sex of the flowers produced by certain plants. Lindley says, "It will be found that no pollen is scattered in damp, cold weather, but in a sunny, warm, dry morning the atmosphere surrounding such plants, is, in the impregnating season, filled with grains of pollen discharged by the anthers. In wet springs the crops of fruit fail, because the anthers are not sufficiently dried to shrivel and discharge their contents, which remain locked up in the anther cell till the power of impregnation is lost."

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* Journal d'Agriculture Pratique, etc.

† Goodale, Breeding, etc. of Domestic Animals. Boston, 1861, pp. 91, 92.

‡ H. M. Congar, M. D., Buffalo Medical and Surgical Journal, August, 1867.

§ Criticism on Dr. Spruce's article, by Dr. Wendland, in Botan. Zeitung, 1869.

‖ The Cause of Rotation and nearly Equal Number of Sexes in Births.

¶ Theory of Horticulture, N. Y., 1852.

Gaertner§ has pointed out in his "Notice sur des Expériences concernant la Fécondation de quelques Végétaux," the decided influence of the state of the atmosphere on the process of fecundation. He insists on the maturity of the pollen as essential to the process. During a warm time the stamens of the rue accomplish their movements in two or three days, whilst they are, by a cold air and an advanced season, scarcely terminated in eight days. Fecundation requires also a greater quantity of pollen in the last case than in the other.||

This being the case, we can readily understand that a few wet days may prevent the pollen from being disseminated, while the ovules continue developing, and fecundation is retarded from this cause, and it is for this reason that the production of a larger proportion of exclusively male-producing grains is due.

Darwin¶ says that "walnut trees, which are properly monœcious, sometimes entirely fail to produce male flowers;" and "the female silver maple will not unfrequently put forth branches of male flowers."

Some cultivator has recorded** a series of experiments on

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*Pamphlet, Phila., 186–.

†Lindley, p. 172, out of Dr. Daubeny, Phil. Trans., 1836, p. 149.

‡Selections from Mr. Knight's Physiological Papers, pp. 347-357, out of the Phil. Trans.

§Naturwissenschaftliche Abhandlungen, Tubingen, 1826. t. 1. . . .

||Koelreuter. Vorlaenfige Nachricht von Einingen das Geschlecht der Pflanzen betreffenden Versuchen, pp. 10, 19, from Gardener's Chronicle, 1847, pp. 541-558.

¶Animals and Plants under Domestication.

**American Agriculturist, N. Y., Orange Judd, M. A., Editor.

Indian corn, with a view of obtaining the largest proportion of stalks bearing two ears. The following was the method employed; all the stalks bearing but one ear had the "tassel" (male flower) cut off before it was full blown, so that all stalks bearing two ears would be surely fecundated by the male flowers of the same or other stalks also bearing two ears, thus securing duplicity on both the male and female sides. In this way, we are told that the proportion of stalks bearing two or more ears, was increased to a considerable extent, by the planting of grains procured by this process.*

A single ovule may be fecundated by the pollen of at least two different varieties, as may be seen from Mr. Arnold's experiments given below†.

From what we have shown, it would appear that the grains near the base of the ear are less variable and more mature than those near the tip, and are consequently more desirable for seed, as they would be likely to give plants more vigorous and prolific.

I may state here that it is the habit of good farmers to select the largest and fairest ears, containing the largest, fullest, and hardest grains, for seed; and that a popular notion prevails that ears having a few remaining glumes of abnormally placed male flowers at the tip of the cob are called "female ears" and are supposed to be more prolific, at least are thought to be more desirable for "seed"; whether there be any foundation for this belief I am not informed, but am inclined to look upon it as a "vulgar error."

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*From James Logan's experiments it would appear as if it were the rule, under ordinary circumstances, for the female flowers of plants in the same hill to be fertilized principally by the pollen from male flowers in the same hill.—Experimenta et Melemetemata de Plantarum Generatione, auctore Jacobo Logan, Leyden, 1739. Translated into English by J. F., and published with original Latin text, opposite page. London, 1747. 8vo, pp. 32, p. 9.

†Mr. Arnold of Paris, Canada, has shown that if the female flowers of an Indian corn plant are submitted to the action of pollen from male flowers of different kinds of corn-plants, each grain of the ear produced shows the effect of both kinds of pollen. In an experiment related, a given female flower was subjected first to the action of pollen from a yellow variety of corn, and then to that taken from a white variety; the result was an ear of corn each grain of which was yellow below and white above. The conclusion presented is, not only that there is an immediate influence on the seed and the whole fruit structure by the application of strange pollen, but the more important fact that one ovule can be affected by the pollen of two distinct parents, and this, too, after some time had elapsed between the first and second impregnation. [From the author's paper on The Laws of Transmission of Resemblance from Parents to their Children. New York Medical Record, 15th of Aug., Sept., Oct., and Nov., 1873, pp. 16—out of Scribner's Monthly, Sept., 1873.]

Columella* and Celsus†, in ancient times laid great stress upon the selection of seed-corn; and Virgil‡ says—

> "I've seen the largest seeds, tho' view'd with care,
> Degenerate unless th' industrious hand
> Did yearly cull the largest." §

To recapitulate then,—the conclusions arrived at in this paper are:—

1. That in plants, and animals as well, that are actively occupied in vegetative, physiological, pathological or other efforts which are antagonistic or complementary to the office of reproduction, the proportion of females borne during such times is greater than where the plant or animal has reached full developmental maturity ‖ and growth, is in good health, and is occupied principally in the process of reproduction. In this latter condition offspring of a higher developmental condition are produced, and the proportion of males is increased.

2. Females are in better condition (that is, they are fatter, more active in growth), more troubled by disease,¶ or other process antagonistic to reproduction where they conceive with females than with males; and they are made poorer, become more exhausted, and less healthy, by the production of female offspring than by male products.

4. It is just possible that the ovules from which females are derived may have a higher initial vitality (vigor) though they be less highly developed than those from which males are derived, yet no egg can properly be said to be predestined *to be* male or female.

5. That female plants like female animals are less highly developed than males, and are the result of an inferior developmental reproductive effort on the part of the female parents.

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*De Re Rustica.

†Darwin; Animals and plants under Domestication, vol. ii, p. 303.

‡Georgics.

§Darwin, *op. cit.*, vol.i, p. 319.

‖ See farther in the author's paper on The Physical Aspects of Primogeniture; or the Relative Viability of Offspring of Different Pregnancies.—New York Medical Record, January 15 and February 15, 1874.

¶ Dr. Gouverneur Emerson was the first to point out the effect of a prevailing epidemic (cholera) in reducing the proportion of male births. See his proof in his paper in the American Journal of Medical Sciences, July, 1848, pp. 78-85.